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Herd health and health management in organic versus conventional dairy herds in Norway

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Abstract

Earlier studies from Norway indicate that organic dairy farms enjoy better animal health than conventional dairy farms. However, these studies use veterinary treatment records and may not reflect the true health status since animal health may be handled differently, i.e. there might be different treatment schemes on organic versus in conventional farms.

A study of animal health and health handling on both organic ($n=149$) and conventional ($n=159$) farms was performed based on information gathered from a mailed questionnaire merged with information from the Norwegian Cattle Health Services and the Norwegian Dairy Herd Recording System.

Based on the original health records, there appeared to be many and large differences in herd health (veterinary) treatment parameters between the two production systems. However, after looking closer into the major diseases problems of mastitis, ketosis, and milk fever and converting from treatment to estimated case load based on questionnaire information about the observed differences in health handling, all that remained was a lower level of acute mastitis in organic dairy herds relative to conventional. When controlling for production level — milk yield being lower in organic herds — no difference between the two groups remained.

We conclude that, based on official health records, there is an apparent difference in animal health performance which is mainly related to an observed difference in health management. The remaining difference in acute mastitis which is not explained by disease handling appears, at least in part, to be associated with a lower intensity of milk production. The impact of these findings in relation to animal welfare as a central issue in organic farming needs further investigations. Finally, the study demonstrates the need for a critical assessment of routinely collected health-related data used in research, in order to make valid inferences regarding animal health performance.
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Keywords: Organic farming; Dairy cattle; Health; Management; Health records

1. Introduction

A major goal of organic livestock production is the enhancement of animal welfare and animal health, for example through prevention of disease (Alrøe et al., 2001; IFOAM, 2005). Along with less use of synthetic

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chemicals, health and welfare may be among the distinctive features of a more nature-friendly production, which was advocated by Tybirk et al. (2004) as a way to achieve a price premium for livestock products. Also, European consumers perceive that organic farming is better for animal welfare (Edwards, 2005). Evidently, animal health and welfare in organic farming need special attention (Hermansen, 2003; Hovi et al., 2003).

Studies of health and health handling on organic dairy farms are few, and those that have compared health performance in conventional and organic farms have given conflicting results (Hovi et al., 2003). In a literature review, Lund and Algers (2003) concluded that 'health and welfare in organic herds are the same as or better than in conventional herds'.

In an earlier Norwegian study, the most frequent health disorders (mastitis, ketosis and milk fever) were investigated. Both Ebbesvik and Løes (1994) and Hardeng and Edge (2001) reported better health performance for organic than for conventional dairy herds and the latter authors found that there was no difference in somatic cell count (SCC) in the milk produced. In another Norwegian study, reproductive parameters were found to be impaired in organic dairy farms, with the poorer performance attributed to a deficit of nutritional energy during the winter season (Reksen et al., 1999).

The results of Hardeng and Edge reported above were based on historical data on treatment from the Norwegian Cattle Health Service health card system. However, as Bennedsgaard et al. (2003) and von Borell and Sørensen (2004) have suggested, there could be systematic differences in health handling e.g. due to a potential systematic different policy for veterinary treatment between organic and conventional dairy farmers, and these differences could have affected the reported difference in health performance. One potential source of such systematic differences is the expected more frequent use of alternative treatments such as homeopathy in organic herds (Hovi and Roderick, 2000; personal communication Britt Henriksen).

In Norway, individual dairy cattle health cards are completed by a veterinarian whenever animals are treated medically, and the recording compliance by the veterinarians is thought to be good (Valde et al., 2004). Health treatments such as homeopathic treatments, not involving a visit by a veterinarian, are less likely to be reported on the cattle health cards. Hence, the health card records count veterinary treated cases and not number of cases occurring.

The aims of this study were: 1) to check for systematic differences in health handling/treatment strategies between organic and conventional dairy farmers; and 2) to use this information to convert the herd health information provided in the official databases to estimated cases occurring in order to investigate differences between organic and conventional dairy herds with respect to this estimated case load.

2. Materials and methods

2.1. Questionnaire

The data reported on are a sub-set of a larger survey of risk and risk management in Norwegian farming (Flaten et al., 2005a,b; Koesling et al., 2004). Both Norwegian crop and dairy farmers were sampled, although in this paper only data from dairy herds are used. Dairy herd size is small in Norway and dairy farms with less than five dairy cows were excluded from the enumeration list.

A 10-page questionnaire was prepared consisting of questions related to: 1) farmers' perceptions of risk, 2) farmers' perceptions of various risk management strategies, 3) farmers' goals, future plans and motivations for their farming system (organic or conventional), 4) animal disease management strategies, and 5) characteristics of the farm and farmer (Flaten et al., 2005a, Appendix 14). The questionnaire was pre-tested on a sample of farmers and refined several times, based on the comments and suggestions received.

Table 1
Key production parameters for sampled organic dairy herds and frequency matched conventional dairy herds by community

	Conventional (n=159)		Organic (n=149)		
	Mean	SD	Mean	SD	
Number of dairy cow years [a]	15.2	6.8	16.3	10.0	
Age of dairy cows (in years)	4.1	0.6	4.5	0.6	*
Milk yield (kg) per cow year	6110	1092	5081	1019	*
Milk delivered (L) per cow year	5408	1012	4388	976	*
Total feed units [b] per cow year	4397	1141	3905	1124	*
Percentage silage	38.6	14.5	39.3	16.2	
Percentage concentrates	39.3	20.1	27.4	22.5	*
Percentage hay	1.5	3.7	3.8	8.1	*
Percentage pasture	16.6	10.7	26.1	12.2	*
Percentage root crops	0.1	0.7	0.4	1.4	*
Percentage potatoes	0.3	1.5	0.3	0.9	
Percentage other feed	0.2	1.1	0.4	1.6	

* Variables marked with an asterisk show that the means of conventional and organic farmers are significantly different according to a two-sample t-test ($P<0.05$).

[a] Cow years' is the number of feeding days from the 1st calving or 1st of January to culling for all dairy cattle in a given year, divided by 365 days.

[b] One feed unit is defined as 6900 kJ of net energy (Ekern, 1991).

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Table 2
Risk-related responses associated with animal health and welfare found to be significantly[a] different between organic and conventional dairy farmers

	Category[b]					
	I		II		III	
Sources of risk	C[c]	O[c]	C	O	C	O
Production diseases	16	31	59	57	25	12
Endemic epidemic animal diseases	9	26	39	45	52	29
Exotic epidemic animal diseases	13	33	19	22	68	45
Animal welfare policy	11	32	25	34	64	34
Agreement with statement						
Conventional farming improves animal health	19	80	45	17	36	3
Organic farming increases the risk of malnutrition	26	59	37	36	37	5
Organic farming better meet animals' natural needs	40	6	50	22	10	72
Stressed economy harms animal welfare and health	17	30	33	41	50	29
Risk management strategies						
Use of veterinary advisory services	10	22	37	50	53	28
Prevent/reduce livestock diseases	2	0	10	19	88	81

[a] $P<0.05$; χ^2-test for categorical data.
[b] Likert-type scale response originally ranging from 1 (unimportant/totally disagree) to 7 (very important/totally agree) pooled for tabulation into 3 categories by merging the responses in 1 and 2 into category I, responses in 3, 4 and 5 into category II and the responses in 6 and 7 into category III. Percentages of responses by farmers engaged in the two types of production are tabulated.
[c] C = conventional; $n=159$ and O = organic; $n=149$.

The organic dairy herds selected were all the registered herds supplying organic milk to TINE Norwegian Dairies BA, i.e. all organic dairy farms delivering milk for commercial use in Norway, thus, representing the Norwegian organic dairy herd population.

The Norwegian Agricultural Authority (SLF) maintains a register of all farmers receiving public farming payments (i.e. including all dairy farmers). The conventional dairy farmers were selected from this SLF-register for the year 2001. As part of a larger study, two groups of conventional dairy farmers were selected — a simple random sample and a frequency matched sample. The latter group had the same number of conventional farms as there were organic farms within each community, and thus also within each veterinary practice (usually consisting of one to three communities). Because veterinary practices are known to affect treatment frequencies in Norway (personal communication Olav Østerås), this potential for confounding was controlled for in this study by only comparing the national organic dairy herd population with the frequency matched sample of conventional dairy herds.

The questionnaire was sent out in January 2003 to 616 conventional dairy farmers and 245 organic dairy farmers. A month later a reminder postcard was sent to all non-respondents. In March the questionnaire was again sent to farmers who had not responded with a covering letter asking for cooperation.

From the original dairy farmers approached, given the inclusion criteria (only frequency matched conventional farms) and after screening the data for misclassifications and highly incomplete questionnaires, the remaining data base consisted of 174 conventional and 162 organic dairy herds.

2.2. Health and production data

Information gathered from individual dairy cow health and production records at the herd level are registered centrally by the Norwegian Cattle Health Services (http://storfehelse.tine.no/engelsk/) and the Norwegian Dairy Herd Recording System. Some 97% of Norwegian dairy farmers participate in this recording system (Østerås, 2003). Since Norwegian farmers are not permitted to initiate veterinary treatments by themselves, the health information is largely related to

Table 3
Key health- and reproduction-related parameters[a] for organic and frequency matched conventional dairy herds

	Conventional ($n=159$)		Organic ($n=149$)		
	Mean	SD	Mean	SD	
Geometric somatic cell count[b]	118	48	126	50	
Calving interval (days)	390	40	388	32	
Culling rate[c]	43	26	37	23	*
Replacement rate[c]	43	22	38	19	*
Treatment for all diseases[c]:	72	63	44	52	*
All mastitis cases	31	27	17	24	*
Acute mastitis	20	19	11	16	*
Clinical mastitis	11	15	6	13	*
Sub-cl./chronical mastitis	0.29	3.0	0.14	1.8	
Trampled teat	2.9	6.2	1.3	4.1	*
Milk fever	5.4	9.9	4.8	7.8	
Ketosis	6.3	12	3.4	8.4	*
Indigestion	1.4	5.5	0.4	1.8	*
Retained placenta	2.8	5.8	1.8	3.6	*
Vulvo-vaginitis	0.7	4.1	0.6	2.7	
Lack of heat	2.4	7.3	0.6	3.2	*
Heat syncronisation	0.4	2.1	0.2	1.9	
Ovarian cysts	1.2	3	0.3	1.6	*

* Means significantly different between the two groups according to a two-sample t-test ($P<0.05$).
[a] Data source: TINE/Cattle Health Service, Dairy Cattle Health Record System.
[b] Geometric mean cell count in thousand per ml in bulk tank milk.
[c] Per 100 cow years (see footnote Table 1).

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visits by veterinarians and their veterinary treatments of the farmers' cattle. A data set (2002 data) from the above two databases documenting individual herd health, reproduction and production information (herd averages) was merged with the questionnaire data. The final data set consisted of 159 frequency matched conventional dairy herds and 149 organic dairy herds that had returned an acceptable completed questionnaire and also were members of the health recording system.

2.3. Statistical analysis

Initially, a simple descriptive analysis was performed to compare this cross-sectional data set from the organic dairy farms and the frequency matched sample of conventional dairy farms with respect to key herd average production and risk related responses. A simple two-sample *t*-test was used for continuous variables ($P<0.05$) and a chi-square-test ($P<0.05$) was used for categorical variables (ordinal Likert-type scale variables included).

In the next step, selected health card record information, i.e., treatments for acute clinical mastitis, mild mastitis, chronic mastitis, ketosis and milk fever, was converted to a new variable based on responses in the questionnaire giving frequency of calling the veterinarian to these disorders. In the questionnaire, cases were defined by objective descriptions such as fever for "acute mastitis" and positive Schalm reaction without fever, for "mild mastitis". Farmers responded to a question asking "how many times out of ten" of these (above) selected health disorders was a veterinarian called to attend". Between groups differences in the calling frequencies were investigated by a two-sample *t*-test ($P<0.05$), and if significant, a comparison based on treatment information was presumed not to be adequate. Each of the annual frequencies for selected health card recordings for each sampled farm was converted (i.e. inflated if less than 10 out of 10) to estimated annual health disorder occurrence, i.e. estimated case load. These converted data was then investigated again for differences between the two production systems using a simple two-sample *t*-test.

Health variables showing signs of association in the *t*-test ($P<0.05$) were tested in a regression procedure. A negative binomial regression approach (Dohoo et al., 2003) in Proc Genmod (SAS®) was used since the dependent variables tested were count variables and over-dispersion in a usual Poisson regression is a common problem (Dohoo et al., 2003). The explanatory variable

Table 4
Application of disease handling/management interventions as reported in questionnaire responses by organic and conventional dairy farmers

	Never		Sometimes		Often		
Mastitis management	C [a]	O [a]	C	O	C	O	
Extra milking of cows treated by a veterinarian	7	10	55	50	38	40	
Extra milking of cows not treated	31	19	47	45	22	36	*
Use of heat liniments	49	33	35	46	16	21	*
Alternative treatments	86	45	8	30	6	25	*
High SCC [b] cows with suckling calves	76	46	17	31	7	23	*
Drying off without treatment	51	35	42	54	7	11	*
Drying off after treatment	9	12	77	80	14	8	
Separate milking	25	22	25	26	50	52	
Culling without treatment	30	36	65	56	5	8	
Ketosis management							
Feeding supplements to ketosis cases	22	44	45	31	33	25	*
More than two daily feedings of concentrates	20	44	21	19	59	37	*
Other feedstuff supplements	23	9	38	37	39	54	*
Use of body scoring	15	13	45	51	40	36	
Use of feeding advisory services	6	25	24	35	70	40	
Milk fever management							
Use of Ca supplements for milk fever (mf) cases	48	56	35	32	17	12	
Use of body scoring for mf prevention	17	18	52	51	31	31	
Use of feeding advisory services	9	29	28	37	63	34	*
Farmers recording routines							
Notes [c] of self-induced health handling	81	73	15	20	4	7	
Notes of self-induced alternative treatments	53	38	26	33	21	29	

* Disease handling significantly different between the two groups according to a χ^2-test ($P<0.05$).
[a] C = conventional; $n=159$ and O = organic; $n=149$.
[b] SCC = Somatic cell count.
[c] The farmer making notes in the Norwegian Cattle Health Services System.

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Table 5
Responses in questionnaire to a question asking to how many out of ten cases of the listed health disorders occurring at the farm, a veterinarian was called

	Conventional (n=154)		Organic (n=136)		
	Mean	SD	Mean	SD	
Acute mastitis	9.8	1.4	8.7	3.1	*
Mild mastitis	4.7	3.4	2.2	2.6	*
Chronic mastitis reported in NCHS [a]	3.9	3.3	2.0	2.0	*
Mastitis in heifers	7.9	3.0	4.8	3.9	*
Ketosis	7.7	3.3	6.2	3.8	*
Milk fever	9.7	1.6	9.3	2.3	

* Means significantly different between the two groups according to a two-sample t-test (P<0.05).
[a] Norwegian Cattle Health Services.

investigated and tested by Wald's test (Dohoo et al., 2003) was farm group (organic=1 and conventional=0, i.e. the reference level) and the control variables (i.e. forced into the model and remaining if p-value>0.2) were average age of dairy cows in the herd, herd size and herd average milk yield. The interaction term between milk yield and farm group was tested in the model for a potential difference in association between milk yield and the dependent variable between the two groups. The impact of the interaction term was tested using the change in log-likelihood and the associated χ^2-statistic (Dohoo et al., 2003).

The (continuous) control variables were investigated for linearity and, if not showing a linear relation, they were modeled as categorical variables represented by their quartiles. Categories (quartiles) not found to be significantly different were pooled.

3. Results

The organic dairy farms and the frequency matched sample of conventional farms showed significant differences in key production parameters such as age distribution of the dairy cows, milk yield, total feed units per cow, percentages of concentrates and of pasture in the total feed ration (Table 1). The share of the produced milk delivered to the dairy factory from organic dairy farms (86%) was significantly less (P<0.05) than for the conventional dairy farms (89%). The basic non-concentrate forage in both groups was silage but the use of supplementary feed, e.g. hay and root crops, was more common in organic herds.

The organic and conventional dairy farmers responded differently with respect to the assessment of risk sources related to health and welfare in terms of their potential impact on the economic performance of their farm (Table 2). Risk sources related to production diseases, domestic (endemic) epidemic diseases and non-domestic (exotic) epidemic diseases, as well as the impact of animal welfare policies, were all perceived less risky among organic farmers.

Strong differences were found between the two groups in relation to statements comparing the two production systems. For example 81% of the organic farmers disagreed with the statement that conventional livestock farming improves animal health, while only 19% of conventional farmers disagreed with the same statement. Some 72% of the organic farmers strongly agreed with the statement that organic farming better meets the needs of the animals, while only 10% of the conventional farmers supported the same statement. Organic farmers were less in agreement with the statement that a downward pressure on dairy farmers' incomes would harm animal welfare and health. Although the two groups of farmers agreed on the importance of risk management in preventing/reducing livestock diseases, organic farmers attached less importance to use of veterinary advice in coping with risk.

When investigating the key health- and reproduction-related variables from the Norwegian Cattle Health Services, the two groups differed for most of the tested variables (Table 3). The treatment frequency for all diseases on organic farms was only 60% of that on conventional farms, with mastitis treatments contributing most of the difference. Treatments for chronic mastitis,

Table 6
Estimated occurrence of key health disorders for conventional and organic dairy farms, based on the reported frequency of calling the veterinarian to health disorders (see Table 5)

	Conventional (n=147)		Organic (n=136)		
	Mean	SD	Mean	SD	
Acute mastitis	22	24	15	24	*
Mild mastitis	43	101	43	114	
Chronic mastitis	1.1	14	0.3	9	
Ketosis	9.9	21	8.7	21	
Milk fever	5.7	10	5.8	10	

* Means significantly different between the two groups according to a two-sample t-test (P<0.05).

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milk fever, vulvo-vaginitis and heat-synchronisation were the exceptions with no significant differences. For other performance measures, no significant difference was observed in calving interval — an indicator for reproductive performance. (Calving interval is an imprecise indicator since it is affected by the culling pattern within the herd.) Nor was there any significant difference between the groups in average SCC from the bulk tank milk.

Disease handling also differed between the two groups (Table 4). Organic farmers applied more of their own resources in taking care of the animals (e.g., frequent milking) without the use of veterinary treatment as well as alternative treatments for mastitis cases. Some 55% of organic farmers used alternative treatments 'sometimes' or 'often' compared to only 14% among conventional farmers. Organic farmers also made more frequent use of other feed supplements for treatment of ketosis. Organic farmers reported that they made less use of the feeding advisory services offered by the dairy factory than did conventional farmers.

There was no indication of difference between the two groups in reporting their own health handling in the Norwegian Cattle Health Recording Services. As a general observation, both groups responded that their own health management/treatment (if applying such measures) was not 'often' reported, e.g., only about 6% 'often' (the average for the two groups) made a note when carrying out frequent milking and only 26% when carrying out an alternative treatment (Table 4).

In response to a question asking to how many out of ten cases of the listed health disorders occurring at the farm a veterinarian was called, organic farmers reported that they called the veterinarian less frequently, except for milk fever, than did conventional farmers (Table 5). Conventional farmers reported, e.g., that on average they called the veterinarian to 4.7 out of ten mild mastitis cases, while organic farmers called the veterinarian to only 2.0 out of ten.

By converting the selected key health variables reported to the recording system based on reported differences in frequency of calling the veterinarian (Table 5), an estimate for the actual disease occurrence in the herds was derived. Subsequent investigations for differences in this estimated health occurrence measures were then found to indicate a difference in the incidence of acute mastitis only (Table 6).

The observed difference in estimated acute mastitis cases based on the conversion was investigated further by the negative binomial regression procedure (Table 7). The significant difference in mastitis occurrence between the two production systems (i.e. "class"; model 1) disappeared when the control variables (milk yield, herd size and average age) were included in the model (model 2). In this model milk yield and herd size were modelled as categories due to non-linearity in relation to mastitis occurrence and the categories based on quartiles 3 and 4 were pooled for both variables since they were not different. The control variable average age was removed from model 2 due to a p-value > 0.2. The interaction term between production systems and milk yield was not significant (change in log likelihood $\chi^2 < 5.99$ with 2 degrees of freedom). We observed a

Table 7
Negative binomial regression models used to test for association between farming system and incidence of acute mastitis (dependent variable) converted to estimated case load based on the farmers' information regarding routines for calling the veterinarian (see Table 5)

Explanatory variables	Model steps with coefficients and standard error. in brackets		
	1 [a]	2 [b]	3 [c]
Intercept	**−1.5 (0.1)** [d]	**−1.66 (0.19)**	**−1.36 (0.27)**
Class [e]	**−0.36 (0.14)**	−0.19 (0.15)	**−0.58 (0.29)**
Herd size 2nd quartile	–	0.06 (0.20)	0.08 (0.20)
3rd and 4th quartile pooled	–	**−0.50 (0.17)**	**−0.51 (0.17)**
Milk yield 2nd quartile	–	0.22 (0.19)	−0.16 (0.32)
3rd and 4th quartile pooled	–	**0.50 (0.18)**	0.17 (0.28)
Interaction class*milk yield 2nd quartile	–	–	0.56 (0.40)
Class*milk yield 3rd and 4th quartile	–	–	0.57 (0.38)
Dispersion parameter	1.1 (0.14)	0.94 (0.12)	0.92 (0.12)

[a] Model with only production system (i.e. class).
[b] Model with predefined control variables (herd size and milk yield) with p-value > 0.2 judged by change in log-likelihood (χ^2). Equal (upper) quartiles were pooled.
[c] Model for testing significance of the interaction term between milk yield and production system (change in log likelihood = 1.37 < 5.99; χ^2 with 2 degrees of freedom).
[d] Explanatory variables significant at $P < 0.05$ in bold (Wald's test).
[e] Class is an indicator variable for organic (=1) and conventional (=0; i.e. the reference level).

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change in the variable "class" when entering this interction term, however, the sample size (power) was too little to show any difference, if present.

4. Discussion

The random sampling within the limitations of the frequency matching of conventional dairy farms to organic farms, combined with the relatively high response rate, means that the samples could be assumed to represent reasonably well both the Norwegian organic dairy farm population and conventional dairy farms with the same spatial distribution as organic dairy herds. However, the sample of conventional dairy farmers is not necessarily representative of the national population of conventional herds.

4.1. General remarks about dairy production in the two groups

The investigation confirms what Hardeng and Edge (2001) have reported earlier that organic dairy herds have a lower milk yield on average than conventional dairy herds in Norway. This and the other reported differences are in accordance with findings of other studies of organic dairy farming, especially in Nordic countries (Lund and Algers, 2003).

It might be a goal of organic farmers to limit the milk yield of their dairy cows in order to have less intense production and so to reduce the problems with mastitis, for example. Such a view seems to be consistent with the reported most important goal for organic dairy farmers in Norway of "sustainable and environmental-friendly farming" (Flaten et al., 2006). However, the finding might also simply be a consequence of the limit set by regulations for organic farming on the use of non-organic feed concentrates.

There was less use of antibiotic treatments in organic herds (Table 3), so it could be expected that a higher percentage of the produced milk would be delivered to the dairy factory. However, both a longer period of calf feeding with cows' milk (regulations require at least 12 weeks) as well as a longer withdrawal period after antibiotic treatments (doubling the legislated withdrawal period), are likely to have contributed to negate this expectation.

4.2. Perception of the risks related to health and welfare in dairy production

Organic farmers were found to be generally less concerned than conventional farmers about potential health threats both from endemic and exotic diseases. This finding might relate to organic farmers more strongly believing that they have a good system for herd health handling, and that they are well protected from risky contacts (with respect to animal health) through their farming system. The rule in organic farming is self-recruitment or recruitment of animals from approved organic farms, which might reduce both the perceived risk as well as the actual risk.

With respect to animal welfare, potential changes in animal welfare policies, which were much discussed in Norway at the time of the questionnaire survey, were perceived as a less important source of risk among organic farmers. Organic farmers might have believed that the Norwegian animal welfare regulations specifically for organic production were stricter than the new general minimum standards to come (Flaten et al., 2005b), meaning that they therefore were already meeting these new regulations.

4.3. Health handling

Organic farmers were apparently more active in handling health disorders among their cattle themselves, for example, by applying extra milking or heat liniments to animals showing signs of mastitis. A higher frequency of these handling procedures has also been reported for Danish organic farmers as actions taken to reduce the use of antibiotics (Vaarst et al., 2006).

As reported by Zwald et al. (2004), Norwegian organic farmers feel less in need of veterinary advisory services than do conventional farmers, perhaps because, as reported by Vaarst et al. (2003), they think that veterinary involvement does not promote the goal of organic farming. Organic farmers use alternative treatments (not involving a veterinarian) to a larger extent than do conventional farmers. In a recent study of Norwegian dairy herds, alternative treatments were found to lack a direct healing effect on mastitis (Hektoen et al., 2004). However, both the self-healing process and the actual effect of supplementary handling measures mean that fewer health disorders are likely to reach the stage where a veterinarian is required.

Only a small percentage of both organic and conventional farmers themselves initiated treatments that were recorded on animal health card records and were thus recorded in the Norwegian Cattle Health Services database. In fact, organic farmers using alternative treatments are not encouraged to record what they do on the health cards by their local veterinarians (personal communication Martha Ebbesvik). Thus, these records contain information primarily derived from visits by

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veterinarians, most often involving veterinary treatment. Hence, this study confirms the need to include more than veterinary treatment records when assessing herd health status on a farm, especially so when there are likely to be systematic differences in handling between the groups under study.

4.4. Health performance

Analysis of the original health card information suggested differences between the two systems in health disorders other than the major ones: mastitis, ketosis and milk fever. However, since the questionnaire did not provide data for checking the calling routines of veterinarians for these disorders, there was no basis for conversion to case load, and so no further analysis was carried out. However, a lower frequency of trampled teat for organic herds may be explained by the observed lower mastitis frequency and fewer reproductive disorders under organic production might relate to the less intense level of production. The observed fewer retained placenta treatments on organic farms is in accordance with other studies (e.g., Bennedsgaard et al., 2003). Based on no significant difference in milk cell count in bulk tanks, we conclude that the lower frequency of mastitis treatments has not led to lower quality delivered milk. Thus, there are no indications of an under-treatment of udder disorders by organic farmers. The calving interval information in this study does not lend support to the findings of Reksen et al. (1999) of poorer reproduction performance in organic versus conventional production. This might be related to the focus created after the publication in 1999, however, due to the crude variable no firm conclusion should be made.

The primary data on the treatments of the major disorders: mastitis, ketosis and milk fever were converted to estimated case loads based on information gathered from the questionnaire to account for difference in frequency of reporting. The estimates of disease occurrence were taken to be more accurate measures of the actual health status in the herds. Unfortunately, however, the conversion procedure may not be wholly reliable. For example, organic farmers may systematically tend to underreport their use of veterinarians. Nevertheless, we believe that the applied method has removed some of the differences due to disease handling, treatment policies and/or treatment thresholds, making a comparison of health performance between the two groups of dairy herds more valid.

Except for acute mastitis, the apparent differences in the major herd disorders between organic and conventional farms, based on the original health service database, disappeared when taking disease handling into account. Thus, the most apparent difference seem to be a systematic difference in health handling, as discussed by Bennedsgaard et al. (2003) and von Borell and Sørensen (2004). There may also have been a confounding to a lesser degree due to generally better animal health status in organic farms.

Based on the reported regression model and when controlling for differences between systems in average milk yield, the difference in acute mastitis incidence was found to be not significant. Of course, this does not negate the fact that there was in fact less acute mastitis on Norwegian organic farms at the time of this study, but at a given production level we cannot conclude that Norwegian organic dairy cows outperform the conventional ones in terms of vulnerability to mastitis.

Whether reduced mastitis frequency is a wished effect or just a consequence of less intensive feeding and thus a lower production level cannot be explicitly answered using the information available from this study. Although the relationship between less use of concentrate feeds, lower milk yield and fewer udder health problems has been found elsewhere, as reported by Hamilton et al. (2006), the matter needs further investigation since the underlying mechanism are uncertain.

According to the European organic livestock regulations (CEC, 1999) and production standards (IFOAM, 2005), there should be focus on animal health including breeding for disease resistance. There was no evidence from this analysis that dairy cows on organic farms have been bred to be more resistant to health disorders than cows on conventional farms. However, this is not surprising since often the same breed (Norwegian Red cattle) and breeding company (GENO) are used both for organic and conventional dairy farming in Norway, and no special “organic semen” is offered.

4.5. Health as part of the animal welfare issue

Animal health is an important component of animal welfare, and is a focus for organic farming (CEC, 1999; IFOAM, 2005; Alrøe et al., 2001; Nicholas et al., 2004; Vaarst et al., 2005; Lund, 2006). A lower frequency of mastitis will have a positive effect in this respect, since mastitis causes a cow pain and/or distress. In addition, the increased level of farmer involvement in the treatment of their animals supports the argument that suffering animal tends to be given more attention and care on organic farms. On the other hand, failing to call the veterinarian for diagnosis and

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veterinary treatment can increase the risk of prolonged suffering and/or distress for infected animals. Yet the lack of any significant difference in SCC between organic and conventional herds seems to negate such a scenario.

A central question for marketing organic is whether the health management of the studied organic herds makes these farms better or worse "places to be" for cows, as perceived by European consumers concerned about animal welfare (Edwards, 2005). Firm conclusions about animal welfare cannot be drawn from this analysis and should be investigated more thoroughly in future research.

5. Conclusion

The primary animal health data used in this analysis did show that the incidence of acute mastitis was lower for organic than conventional dairy herds. However, the difference is explained, at least in part, by the lower production level on organic dairy farms.

No evidence was found to support a proposition that organic dairy cows are healthier than those on conventional farms. The lower level of mastitis together with a higher usage of pasture might be held to support the idea of better animal welfare under organic dairy production although no value judgment is thereby implied that standards of animal welfare on conventional farms are too low. Since animal health performance is an important component of public perceptions about animal welfare, particularly relevant to marketing organic livestock products, animal health and health handling should be looked into more closely.

Finally, this study shows that not all animal health disorders occurring on dairy farms are reported to the Norwegian Cattle Health Services system. Systematic differences in health handling between the two groups studied — organic and conventional — were present, and made it necessary to collect additional information in order to arrive at what are argued to be a more valid comparison of the health performance in the two groups. Hence, the need for a critical assessment of health-related data sources used in research is reinforced by this study.

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References

Alrøe, H.F., Vaarst, M., Kristensen, E.S., 2001. Does organic farming face distinctive livestock welfare issues? A conceptual analysis. J. Agric. Environ. Ethics 14, 275–299.

Bennedsgaard, T.W., Thamsborg, S.M., Vaarst, M., Enevoldsen, C., 2003. Eleven years of organic dairy production in Denmark: herd health and production related to time of conversion and compared to conventional production. Livest. Prod. Sci. 80, 121–131.

CEC, 1999. Council Regulation on Organic Livestock Production. Committee of the European Communities, Brussels. 1804/1999.

Dohoo, I., Martin, W., Stryhn, H., 2003. Veterinary Epidemiologic Research. AVC Inc., Charlottetown.

Ebbesvik, M., Løes, A.K., 1994. Organic dairy production in Norway. Feeding, health, fodder production, nutrient balance and economy. Results from the "30 Farm-Project", 1989–1992. In: Granstedt, A., Koistinen, R. (Eds.), Converting to Organic Agriculture. Scand. Assoc. Agric. Sci. Rapp., vol. 93, pp. 35–42.

Edwards, S.A., 2005. Product quality attributes associated with outdoor pig production. Livest. Prod. Sci. 94, 5–14.

Ekern, A., 1991. Nytt system for energivurdering av fôr til drøvtyggere. Nor. Landbruksforsk. 5, 273–277.

Flaten, O., Lien, G., Ebbesvik, M., Koesling, M., Valle, P.S., 2005a. Risiko og risikohandtering i økologisk jordbruksproduksjon. Report 2005–4. Norwegian Agricultural Economics Research Institute (In Norwegian).

Flaten, O., Lien, G., Koesling, M., Valle, P.S., Ebbesvik, M., 2005b. Comparing risk perceptions and risk management in organic and conventional dairy farming: empirical results from Norway. Livest. Prod. Sci. 95, 11–25.

Flaten, O., Lien, G., Ebbesvik, M., Koesling, M., Valle, P.S., 2006. Do the new organic producers differ from the "old guard"? Empirical results from Norwegian dairy farming. Renew. Agric. Food Syst. 21, 174–182.

Hamilton, C., Emanuelson, U., Forslund, K., Hansson, I., Ekman, T., 2006. Mastitis and related management factors in certified organic dairy herds in Sweden. Acta Vet. Scand. 48.

Hardeng, F., Edge, V.L., 2001. Mastitis, ketosis, and milk fever in 31 organic and 93 conventional Norwegian dairy herds. J. Dairy Sci. 84, 2673–2679.

Hektoen, L., Larsen, S., Ødegaard, S.A., Løken, T., 2004. Comparison of homeopathy, placebo and antibiotic treatment of clinical mastitis in dairy cows — methodological issues and results from a randomized-clinical trial. J. Vet. Med. Ser. A-Physiol. Pathol. Cl. Med. 51, 439–446.

Hermansen, J.E., 2003. Organic livestock production systems and appropriate development in relation to public expectations. Livest. Prod. Sci. 80, 3–15.

Hovi, M., Roderick, S., 2000. Mastitis and mastitis control in strategies in organic milk. Cattle Pract. 8, 259–264.

Hovi, M., Sundrum, A., Thamsborg, S.M., 2003. Animal health and welfare in organic livestock production in Europe — current state and future challenges. Livest. Prod. Sci. 80, 41–53.

IFOAM, 2005. IFOAM Norms for Organic Production and Processing, Germany.

Koesling, M., Ebbesvik, M., Lien, G., Flaten, O., Valle, P.S., Arntzen, H., 2004. Risk and risk management in organic and conventional cash crop farming in Norway. Acta Agric. Scand., Sect. C Food Econ. 1, 195–206.

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Lund, V., 2006. Natural living — a precondition for animal welfare in organic farming. Livest. Sci. 100, 71–83.

Lund, V., Algers, B., 2003. Research on animal health and welfare in organic farming — a literature review. Livest. Prod. Sci. 80, 55–68.

Nicholas, P.K., Padel, S., Cuttle, S.P., Fowler, S.W., Hovi, M., Lampkin, N.H., Weller, R.F., 2004. Organic dairy production: a review. Biol. Agric. Hortic. 22, 217–249.

Østerås, O., 2003. Helsekortordninga 2002 [Health card system 2002.]. Norsk Vet. 115, 431–442.

Reksen, O., Tverdal, A., Ropstad, E., 1999. A comparative study of reproductive performance in organic and conventional dairy husbandry. J. Dairy Sci. 82, 2605–2610.

Tybirk, K., Alrøe, H.F., Frederiksen, P., 2004. Nature quality in organic farming: a conceptual analysis of considerations and criteria in a European context. J. Agric. Environ. Ethics 17, 249–274.

Vaarst, M., Thamsborg, S.M., Bennedsgaard, T.W., Houe, H., Enevoldsen, C., Aarestrup, F., de Snoo, A., 2003. Organic dairy farmers decision making in the first 2 years after conversion in relation to mastitis treatments. Livest. Prod. Sci. 80, 109–120.

Vaarst, M., Padel, S., Hovi, M., Younie, D., Sundrum, A., 2005. Sustaining animal health and food safety in European organic livestock farming. Livest. Prod. Sci. 94, 61–69.

Vaarst, M., Bennedsgaard, T.W., Klaas, I., Nissen, T.B., Thamsborg, M., Østergaaerd, S., 2006. Development and daily management of an explicit strategy of nonuse of antimicrobial drugs in twelve Danish organic dairy herds. J. Dairy Sci. 89, 1842–1853.

Valde, J.P., Lawson, L.G., Lindberg, A., Agger, J.F., Saloniemi, H., Østerås, O., 2004. Cumulative risk of bovine mastitis treatments in Denmark, Finland, Norway and Sweden. Acta Vet. Scand. 45, 201–210.

von Borell, E., Sørensen, J.T., 2004. Organic livestock production in Europe: aims, rules and trends with special emphasis on animal health and welfare. Livest. Prod. Sci. 90, 3–9.

Zwald, A.G., Ruegg, P.L., Kaneene, J.B., Warnick, L.D., Wells, S.J., Fossier, C., Halbert, L.W., 2004. Management practices and reported antimicrobial usage on conventional and organic dairy farms. J. Dairy Sci. 87, 191–201.

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